WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

TITLE: Instream Flow Studies on Huff Creek, a Bonneville Cutthroat Trout (*Oncorhynchus clarki utah*) Stream.

PROJECT: IF-4094-07-9306

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ABSTRACT

Instream flow studies were initiated in 1993 on Huff Creek to complement ongoing monitoring of Bonneville cutthroat trout (BRC) index streams (Remmick et al. 1993). Studies were designed to determine instream flows needed to maintain or improve BRC populations.

Physical Habitat Simulation (PHABSIM), the Habitat Quality Index (HQI), and the Habitat Retention Method were used to derive flow recommendations. Recommendations are as follows: April 15 - June 30 = 6.5 cfs, July 1 - September 30 = 3.3 cfs, October 1- April 14 = 1.3 cfs.

INTRODUCTION

Bonneville cutthroat trout (*Oncorhynchus clarki utah*) populations in Wyoming are restricted to tributaries of the Bear River - primarily the Thomas Fork and Smiths Fork watersheds. Physical, chemical, and biological characteristics of the Bear River drainage were inventoried between 1966 and 1977 (Miller 1977). Binns (1981) reviewed the distribution, genetic purity, and habitat conditions associated with populations of Bonneville cutthroat trout. Results of more recent population and habitat surveys are presented in Remmick (1981, 1987) and Remmick et al. (1993). In general, areas with low populations are limited by seasonally low flows, lack of riparian cover elements, thermal pollution arising in conjunction with low flows and reduced riparian vegetation, and silt pollution.

The Bonneville Cutthroat trout was recently petitioned for listing under the Endangered Species Act. Status review was initiated in response to concerns expressed by Idaho Fish and Game, the Desert Fishes Council and the Utah Wilderness Association. A 5-year management plan for Wyoming, which was developed by the Wyoming Game and Fish Department (WGFD) in coordination with the U.S. Forest Service (USFS) and U.S. Bureau of Land Management (BLM), outlines management goals and recommends criteria for listing Bonneville cutthroat trout as threatened (Remmick et al. 1993). The plan recommends that status decisions be made after a five-year population and habitat monitoring period. Fish management and other land management practices could be significantly affected by potential listing of Bonneville cutthroat trout as Threatened and Endangered. Identification and acquisition of Instream Flow water rights is a critical element to avoid such an action on all streams containing Bonneville cutthroat trout.

One objective outlined in the management plan is to "describe existing habitat conditions, establish habitat condition objectives, and determine the impacts of past, present or proposed land management activities for all index streams by 1997." Index streams include a range of stream types for which significant habitat information and data on Bonneville cutthroat trout populations exists. In pursuit of this objective, the Instream Flow Crew initiated studies in 1993 on the following index streams: Coal Creek (Howland), Huff Creek, and Hobble Creek. This report details the results of studies on Huff Creek.

Specifically, the objectives of this study were to 1) investigate the relationship between discharge and physical habitat for Bonneville cutthroat trout and, 2) determine an instream flow necessary to maintain or improve Bonneville cutthroat trout populations.

METHODS

Study Area

Huff Creek is a tributary to the Thomas Fork River (Fig. 1). Historically, this stream received extensive impacts from grazing and the application of herbicides (Binns 1981). Willows (*Salix* sp.) have been nearly eliminated from the lower drainage and the riparian community currently consists of sagebrush (*Artemesia tridentata*) and grass (*Poa* sp.). Grasses increase in abundance with distance from the stream bank but sedges (*Carex* sp.) now dominate along the stream banks following improved grazing management. Efforts to improve stream conditions included BLM changes in livestock grazing practices and construction of two exclosures - a 2 acre lower unit constructed in 1976 and a 38 acre upper unit built in 1979. In addition, in 1983 WGFD completed construction of numerous habitat improvement structures. Effects of these habitat management steps on Bonneville cutthroat trout populations and habitat were assessed by Remmick and Binns (1987).

Bonneville cutthroat trout populations in Huff Creek were assigned a "B" purity rating by Dr. Robert Behnke (Remmick et al. 1993). This indicates an essentially pure population with either very minor differences in meristic characters or a history of stocking non-native *Onchorhynchus* species. Population data collected in 1991 indicate an average of 69 trout/mile (Remmick et al. 1993). Average length was 6.9 in. (range = 4.8-12.0 in.). Population estimates in 1993 indicate an average of 89 trout/mile (ave. length = 6.4, range = 2.4-12.3 in.). Low populations may not be directly due to poor habitat but rather may be a consequence of the low flows experienced by Huff Creek in the last several years (Ron Remmick, pers. comm.). For example, populations in 1987 averaged 372 trout/mile.

A study site was located below the small, lower exclosure at Remmick and Binns' (1987) station A (Township 28N, Range 119W, Section 27). This site was chosen to capitalize on past efforts and because this site is representative of common habitat attributes in lower Huff Creek. The stream has moderate gradient and flows through

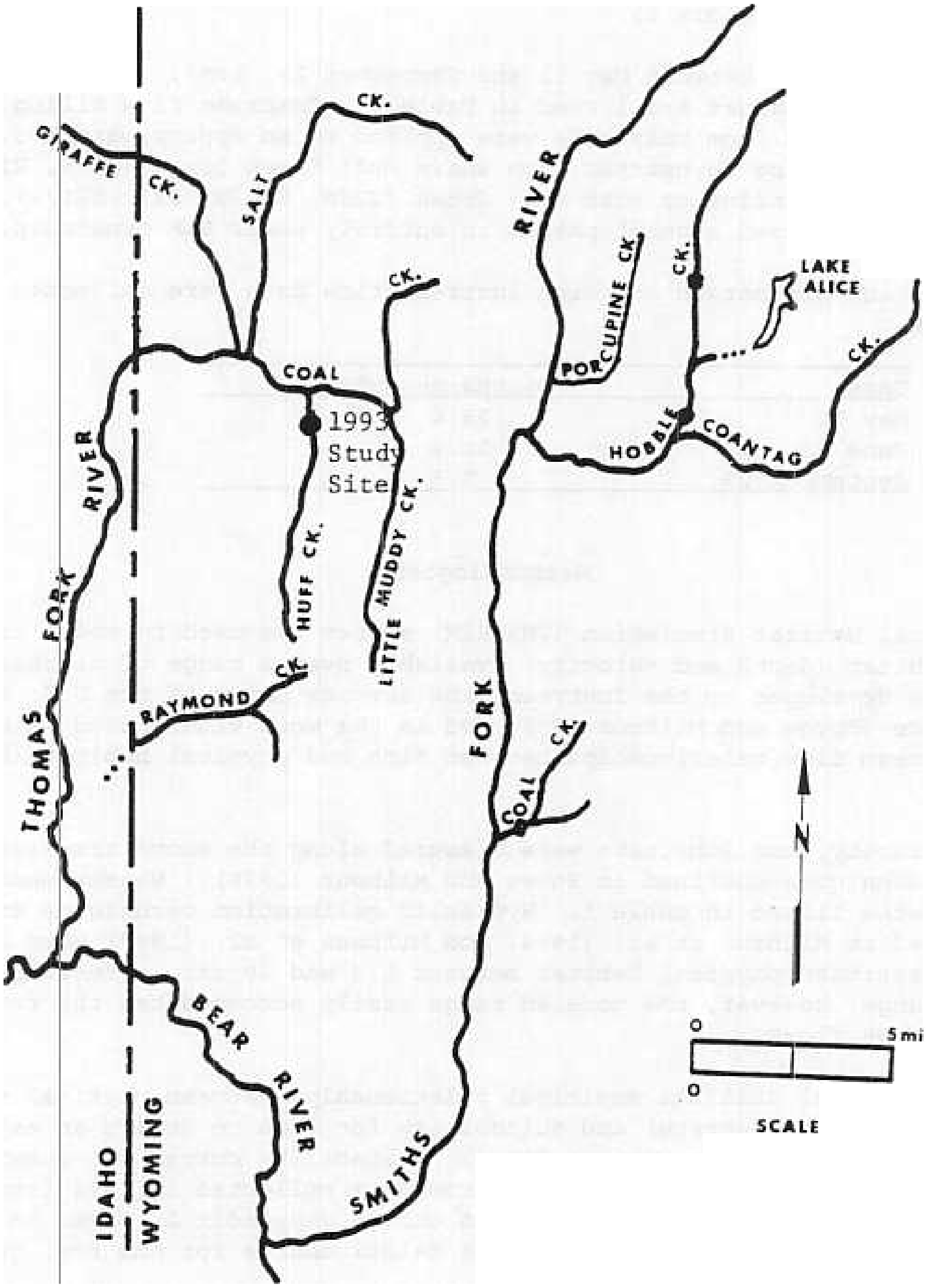

Figure 1 The Smiths Fork and Thomas Fork drainages.

a dry, open meadow. Trout cover is associated with deep holes and deep runs along banks. Twelve transects were distributed among deep pool, shallow pool, run, and riffle habitat types (Appendix 1).

Data were collected between May 12 and September 29, 1993. Collection dates and corresponding discharges are listed in Table 1. Instream flow filing recommendations derived from this site were applied to an approximately 3.0 mile-long reach extending downstream from where Huff Creek forks (T27N, R119W, S10, NW1/4) nearly to the confluence with Coal Creek (T26N, R119W, S27, NE1/4). The land through which the proposed segment passes is entirely under BLM ownership.

Table 1 Dates and discharges at which instream flow data were collected from Huff Creek.

Date	Discharge (cfs)
May 12	25.0
June 23	11.0
September 29	2.5

Methodologies

The Physical Habitat Simulation (PHABSIM) system was used to model the quantity of physical habitat (depth and velocity) available over a range of discharges. This methodology was developed by the Instream Flow Service Group of the U.S. Fish and Wildlife Service (Bovee and Milhous 1978) and is the most widely used method for assessing instream flow relationships between fish and physical habitat (Reiser et al. 1989).

Depth, velocity, and substrate were measured along the above transects according to techniques outlined in Bovee and Milhous (1978). Measurements were taken on the dates listed in Table 1. Hydraulic calibration techniques and modeling options outlined in Milhous et al. (1984) and Milhous et al. (1989) were employed to incrementally estimate physical habitat between 1.0 and 40 cfs. Precision declines outside this range; however, the modeled range easily accommodates the range of typical Huff Creek flows.

The PHABSIM model utilizes empirical relationships between physical variables (depth, velocity, and substrate) and suitability for fish to derive an estimate of weighted usable area (WUA) at various flows. Suitability curves for spawning Bonneville cutthroat trout were developed from data collected in 1994 from Huff Creek (Appendix 2). General cutthroat trout curves (Appendix 2, Bovee 1978) were used to determine discharge-physical habitat relationships for the fry, juvenile and adult life stages.

Critical Bonneville cutthroat trout life stages in Huff Creek and time periods of importance are identified in Table 2. Critical life stages are those life stages most sensitive to environmental fluctuations. Population integrity is sustained by providing adequate flow for critical life stages. In many cases, Rocky Mountain stream populations are constrained by spawning and young (fry and juvenile) life stage habitat bottlenecks (Nehring and Anderson 1993). On Huff Creek, observations indicate that spawning habitat is likely a critical factor influencing trout populations.

According to estimates by Binns (1981), spawning in Huff Creek (elevation 6430-6655) should peak in early to middle May. In 1994, spawning BRCs were observed on May 11. To provide latitude for inter-annual flow and temperature variation, the spawning period should be recognized as April 15 to June 30. Even if spawning is completed by June 1, maintaining flows at a selected level throughout June will benefit incubation. The PHABSIM system was used to derive flow recommendations for spawning Bonneville cutthroat trout from April 15 to June 30 (Table 2). Physical habitat for adults, fry and juveniles was also determined with the PHABSIM system but was not used in deriving instream flow recommendations. These data were included for reference.

Table 2 Bonneville cutthroat trout life stages considered in development of instream flow recommendations for Huff Creek. Numbers indicate method used to determine flow requirements.

LIFE STAGE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Adult							1	1	1			
Spawning				2	2	2						
All stages	3	3	3							3	3	3

1 - Habitat Quality Index
2 - PHABSIM
3 - Habitat Retention

The Habitat Quality Index (HQI; Binns and Eisermann 1979) was used to estimate trout production over a range of late summer flow conditions. This model was developed by the WGFD and received extensive testing and refinement. It has been reliably used in Wyoming for assessment of trout standing stock gains or losses associated with projects that modify instream flow regimes. The HQI model includes nine attributes addressing biological, chemical, and physical aspects of trout habitat. Results are expressed in trout Habitat Units (HUs), where one HU is defined as the amount of habitat quality that will support 1 pound of trout. HQI results were used to identify the average flow needed to maintain or improve existing levels of Bonneville cutthroat trout production between July 1 and September 30.

In the HQI analysis, habitat attributes measured at various flow events are assumed to be typical of mean late-summer flow conditions. Under this assumption, HU estimates can be extrapolated through a range of potential late summer flows (Conder and Annear 1987). Huff Creek habitat attributes were measured on the same dates that PHABSIM data were collected (Table 1). Some attributes were mathematically derived to establish the relationship between discharge and trout production at discharges other than those measured. The estimate of average daily flow was obtained from Binns (1981) and is based on watershed areas and flow at Thomas Fork gage #10041000. A maximum temperature of 77° F was used (Binns 1981). An average peak flow for calculation of ASFV (37.5 cfs) was estimated by increasing the measured high flow (25 cfs) by 50%. This estimate is conservative because it maximizes predictions of ASFV while remaining below the estimated bankfull discharge (38.8 cfs).

A Habitat Retention method (Nehring 1979, Annear and Conder 1984) was used to identify maintenance flows at three riffle transects. Maintenance flow is defined as the continuous flow required to maintain minimum hydraulic criteria in riffle areas of a stream. Year-round maintenance of these criteria ensures passage between habitat types for all trout life stages. In addition, the criteria ensure adequate survival of benthic invertebrates. A maintenance flow is realized at the discharge for which any two of the three criteria in Table 3 are met at all riffle transects in a study area. The instream flow recommendations from the Habitat Retention method are applicable year round except when higher instream flows are required to meet other fishery management purposes (Table 2).

Table 3 Hydraulic criteria for determining maintenance flow with the Habitat Retention method.

Category	Criteria
Mean Depth (ft)	Top width[1] X 0.01
Mean Velocity (ft/s)	1.00
Wetted Perimeter (%)[2]	50

1 - At average daily flow. Minimum depth = 0.20
2 - Percent of bank full wetted perimeter

RESULTS AND DISCUSSION

PHABSIM Analysis

Weighted usable area estimates for four life stages of cutthroat trout are illustrated in Figure 2. PHABSIM analysis indicates that a flow of 6.5 cfs maximizes physical area for spawning (Fig. 2A). Therefore, an instream flow of 6.5 cfs is recommended for the period April 15 to June 30.

Adult physical habitat is maximized at discharges of 14 - 18 cfs and drops off at higher or lower flows (Fig. 2A). Juvenile cutthroat trout physical habitat peaks at 12 cfs and decreases significantly only at flows less than about 5.0 cfs. Fry physical habitat is highest at 7.0 cfs, drops precipitously at lower flows and decreases more slowly at higher discharges (Fig. 2B).

Habitat Unit Analysis

HQI analysis indicates that at existing late summer flow conditions (estimated at 2.5 cfs from September 1993 data), Huff Creek supports approximately 15 trout HUs (Fig. 3). This number of HUs is maintained at a range of late summer flows between 2.2 and 3.2 cfs. Trout habitat is highest (23 HUs) between 8 and 15 cfs and nearly as high (21 HUs) in the 3.3 to 8 cfs range.

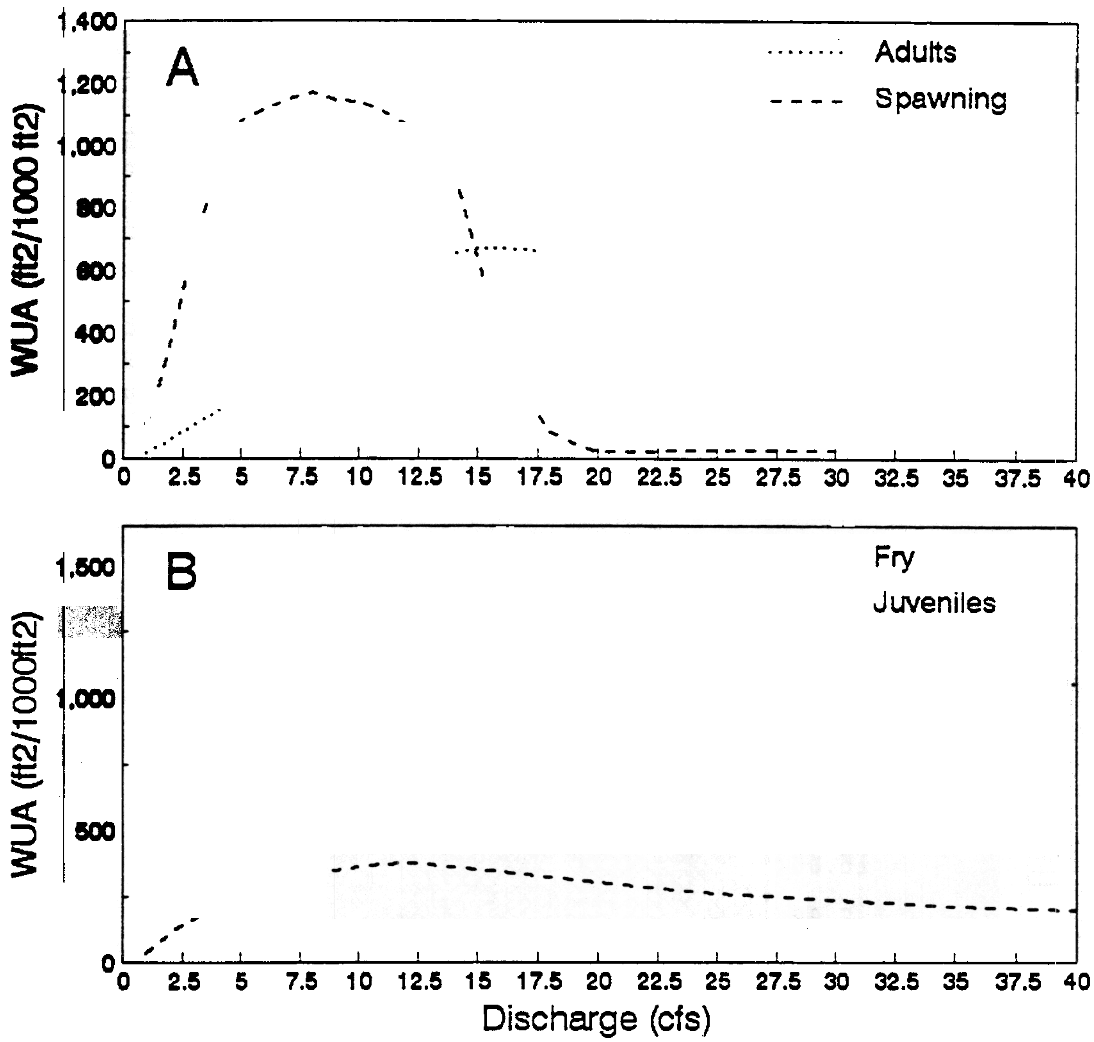

Figure 2. (A) Adult and spawning Weighted Usable Area (WUA) for a range of discharges on Huff Creek. (B) Fry and juvenile WUA.

An increase in late summer flow to 3.3 cfs would nearly maximize habitat unit gains at a level of 21.0 HU's. In light of the 5-year Management Plans' emphasis on increasing Bonneville cutthroat trout populations in areas where they are low (Remmick et al. 1993), instream flow recommendations should attempt to maintain improved populations of Bonneville cutthroat trout. This strategy is appropriate considering the species Category II status and represents a legitimate effort to avoid listing of the species under the Threatened and Endangered Species Act. Listing of the Bonneville cutthroat trout may compromise state fisheries and land management opportunities in the Bear River drainage.

Based on the results of the HQI analysis and in consideration of the goals of the Bonneville cutthroat trout Management Plan (Remmick et al. 1993), an instream flow of 3.3 cfs is recommended to improve existing levels of trout production between July 1 and September 30.

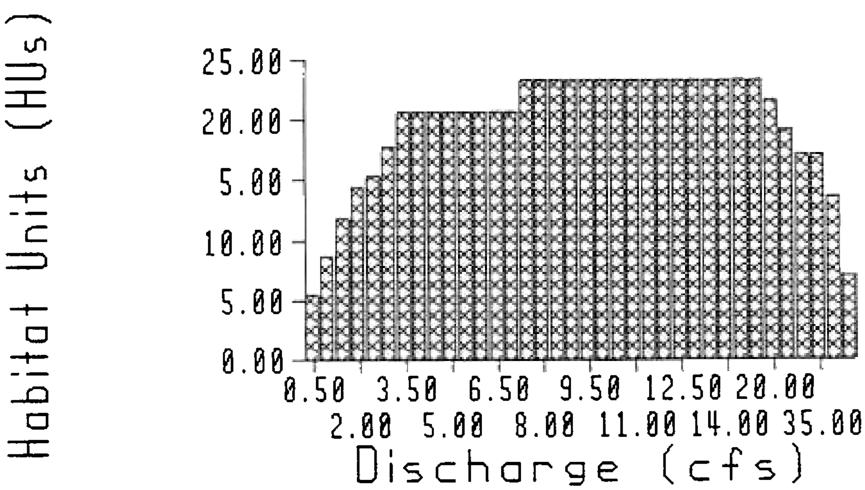

Figure 3 Trout habitat units at several late summer flow levels in Huff Creek

Habitat Retention Analysis

Habitat retention results indicate that a flow of 1.3 cfs is required to maintain hydraulic criteria at all riffles to provide passage for all life stages of trout between habitats (Table 4).

Table 4. Simulated hydraulic criteria for three riffles on Huff Creek Average daily flow = 6.0 cfs. Bank full discharge = 38.8 cfs.

	Mean Depth (ft)	Mean Velocity (ft/s)	Wetted Perimeter (ft)	Discharge (cfs)
Riffle 1	0.91	4.06	11.9	38.8
	0.77	3.12	11.5	25.0
	0.67	2.47	11.2	17.0
	0.56	1.94	10.9	11.0
	0.41	1.32	10.0	5.0
	0.31	1.00[1]	9.6	2.8
	0.29	0.96	9.5	2.5
	0.22	0.79	9.2	1.5
	0.22	0.69	6.5	1.0
	0.21[1]	0.61	5.9[1]	0.7[2]
Riffle 2	0.83	4.44	11.4	38.8
	0.74	3.64	10.1	25.0
	0.64	3.03	9.5	17.0
	0.53	2.49	8.9	11.0
	0.37	1.73	8.2	5.0
	0.26	1.27	7.8	2.5
	0.20[1]	1.04	7.7	1.5
	0.18	1.00[1]	7.6	1.3[2]
	0.16	0.87	7.5	1.0
	<.12	<.81	<7.4[1]	<.7
Riffle 3	1.08	3.39	11.8	38.8
	0.92	2.98	10.1	25.0
	0.81	2.66	8.7	17.0
	0.66	2.33	7.8	11.0
	0.45	1.75	6.8	5.0
	0.32	1.34	6.2	2.5
	0.28	1.20	5.9[1]	1.9
	0.26	1.18	5.1	1.5
	0.21	1.02[1]	4.8	1.0[2]
	0.20[1]	0.96	4.7	0.9

1 - Minimum hydraulic criteria met
2 - Discharge at which 2 of 3 hydraulic criteria are met

Based on habitat retention results, an instream flow of 1.3 cfs is recommended for the October 1 to April 15 time period. According to PHABSIM results, adult, juvenile, and fry cutthroat trout have relatively low levels of physical habitat available at this flow (Fig. 2). However, flows would need to be increased significantly from 1.3 cfs to yield marked increases in adult physical habitat. Given the typically low winter flows experienced by Huff Creek, the trout population has likely adapted with survival strategies such as seeking out deep holes. The recommended instream flow of 1.3 cfs would likely maintain populations at current levels.

Trout populations are naturally limited by low flow conditions during the winter months (October through March; Needham et al. 1945, Reimers 1957, Butler 1979, Kurtz 1980). Such factors as snow fall, cold intensity, and duration of cold periods can influence winter trout survival. Fish populations are influenced through the effects of frazile ice (plugged gills), anchor ice (ice dams and subsequent stranding), and collapsing snow banks (suffocation). Another important consideration is excessive metabolic stress incurred at low temperatures (Cunjak 1988).

These causes of winter mortality are all greatly influenced by winter flow levels. Higher flows inherently minimize temperature changes and subsequent trout mortality. Any reduction of natural winter stream flows would increase trout mortality and effectively reduce the number of fish that the stream could support. Therefore protection of natural winter stream flows up to the recommended maintenance flow is necessary to maintain existing survival rates of trout populations.

The 1.3 cfs identified by the Habitat Retention Method may not always be present during the winter. Because the existing fishery is adapted to natural flow patterns, occasional periods of natural shortfall during the winter do not necessarily imply a need for additional storage. Instead, they illustrate the necessity of maintaining all natural winter streamflows, up to 1.3 cfs, to maintain existing survival rates of trout populations.

FLOW RECOMMENDATIONS

Based on the analyses and results outlined above, the instream flow recommendations in Table 5 will maintain or improve the existing Huff Creek Bonneville cutthroat trout fishery. These recommendations apply to an approximately 3.0 mile segment of Huff Creek extending downstream from the confluence of the two Huff Creek forks (T27N, R119W, S10, NW1/4) to the BLM boundary near Coal Creek (T28N, R119W, S27, NE1/4).

Table 5 Summary of instream flow recommendations to maintain or improve the existing trout fishery in Huff Creek.

Time Period	Instream Flow Recommendation (cfs)
April 15 to June 30	6.5
July 1 to September 30	3.3
October 1 to April 14	1.3[1]

1 To maintain existing natural stream flows

This analysis does not consider periodic requirements for channel maintenance flows. Because this stream is presently unregulated, channel maintenance flow needs are adequately met by natural runoff patterns. If the stream is regulated in the future, additional studies and recommendations may be appropriate for establishing flow requirements for channel maintenance.

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Appendix 1. Reach weighting used for PHABSIM analysis.

SEGMENT 1

STAID	LENGTH	WEIGHT	PERCENT	HABITAT TYPE
0.00	5.25	1.00	3.26	RIFFLE
17.50	14.55	1.00	9.03	POOL
22.10	6.10	1.00	3.79	POOL
29.70	14.52	1.00	9.01	RUN
43.10	6.53	1.00	4.05	RIFFLE/RUN
50.80	13.79	1.00	8.56	POOL
65.00	11.81	1.00	7.33	RIFFLE
80.10	17.75	1.00	11.02	RUN
100.50	15.18	1.00	9.42	RIFFLE
117.10	19.37	1.00	12.02	RIFFLE/RUN
132.60	36.25	0.61	13.66	RUN
161.10			8.85	RIFFLE

Appendix 2. Suitability index data used for PHABSIM analysis (Bovee 1978). Fry substrate codes were changed to indicate no substrate preference.

	VELOCITY	WEIGHT	DEPTH	WEIGHT	SUBSTRATE	WEIGHT
FRY	0.00	0.00	0.00	0.00	0.00	1.00
	0.10	0.00	0.40	0.00	100.00	1.00
	0.15	0.09	0.50	0.12		
	0.25	0.38	1.00	0.64		
	0.30	0.70	1.05	0.71		
	0.35	0.90	1.10	0.77		
	0.40	0.99	1.15	0.88		
	0.45	1.00	1.20	0.96		
	0.50	0.99	1.25	0.99		
	0.55	0.90	1.30	1.00		
	0.60	0.82	1.55	1.00		
	0.70	0.69	1.60	0.98		
	0.75	0.63	1.65	0.92		
	0.80	0.58	1.70	0.85		
	0.90	0.50	1.80	0.74		
	1.00	0.43	1.90	0.66		
	1.25	0.30	2.00	0.59		
	1.50	0.20	2.10	0.54		
	1.60	0.17	2.20	0.50		
	1.70	0.14	2.30	0.46		
	1.85	0.10	2.45	0.41		
	2.00	0.08	2.55	0.39		
	2.20	0.05	2.70	0.37		
	2.30	0.04	2.85	0.36		
	2.50	0.03	3.05	0.34		
	2.75	0.02	3.20	0.32		
	2.90	0.00	3.30	0.31		
	100.00	0.00	3.50	0.26		
			3.70	0.20		
			3.80	0.16		
			3.90	0.10		
			3.95	0.06		
			4.00	0.00		
			100.00	0.00		
JUVENILE	0.00	0.00	0.00	0.00	0.00	0.00
	0.10	0.00	0.50	0.00	4.00	0.00
	0.20	0.12	0.65	0.08	4.20	0.08
	0.30	0.30	0.70	0.10	4.30	0.13
	0.40	0.59	0.80	0.18	4.40	0.18
	0.45	0.83	0.90	0.26	4.50	0.24
	0.50	0.95	0.95	0.32	4.60	0.30
	0.55	0.98	1.10	0.50	4.70	0.37
	0.65	1.00	1.20	0.68	4.80	0.45
	1.05	1.00	1.30	0.94	5.00	0.63
	1.15	0.99	1.35	0.98	5.10	0.70
	1.25	0.97	1.45	1.00	5.20	0.75
	1.40	0.94	1.50	1.00	5.30	0.80
	1.50	0.91	1.60	0.98	5.50	0.87
	1.60	0.87	1.65	0.93	5.70	0.94
	1.65	0.85	1.70	0.87	5.90	0.98
	1.70	0.82	1.75	0.82	6.00	1.00
	1.75	0.77	1.80	0.78	6.10	0.97
	1.85	0.56	1.95	0.70	6.40	0.84
	1.90	0.46	2.10	0.62	6.60	0.74
	1.95	0.42	2.25	0.56	7.00	0.48
	2.05	0.32	2.70	0.41	7.20	0.36
	2.10	0.28	3.00	0.28	7.40	0.26
	2.15	0.25	3.30	0.17	7.60	0.19
	2.30	0.19	3.55	0.10	7.80	0.11
	2.40	0.16	3.65	0.07	8.00	0.06
	2.65	0.12	3.75	0.05	100.00	0.00
	2.75	0.10	3.90	0.03		
	2.85	0.07	4.15	0.00		
	3.00	0.00	100.00	0.00		
	100.00	0.00				

Appendix 2. cont.

	VELOCITY	WEIGHT	DEPTH	WEIGHT	SUBSTRATE	WEIGHT
ADULTS	0.00	0.00	0.00	0.00	0.00	0.00
	0.10	0.00	1.00	0.00	4.00	0.00
	0.25	0.31	1.05	0.02	4.20	0.08
	0.35	0.49	1.10	0.06	4.30	0.13
	0.45	0.61	1.15	0.14	4.40	0.18
	0.55	0.70	1.20	0.68	4.60	0.32
	0.70	0.81	1.25	0.88	4.70	0.42
	0.80	0.87	1.30	0.94	4.80	0.55
	0.90	0.92	1.35	0.96	4.90	0.70
	1.00	0.96	1.40	0.98	5.00	0.93
	1.10	0.98	1.55	1.00	5.10	0.97
	1.20	1.00	1.75	1.00	5.20	0.99
	1.70	1.00	1.85	0.97	5.40	1.00
	1.80	0.98	1.95	0.92	6.70	1.00
	1.85	0.97	2.00	0.88	6.80	0.99
	1.90	0.95	2.05	0.82	6.90	0.96
	2.00	0.90	2.10	0.78	7.00	0.91
	2.15	0.80	2.20	0.71	7.10	0.78
	2.25	0.71	2.30	0.65	7.20	0.66
	2.35	0.59	2.45	0.58	7.30	0.57
	2.40	0.51	2.60	0.53	7.40	0.50
	2.50	0.30	2.75	0.49	7.50	0.44
	2.55	0.17	2.95	0.44	7.70	0.36
	2.60	0.11	3.25	0.38	7.80	0.32
	2.65	0.08	3.60	0.32	7.90	0.29
	2.70	0.06	4.75	0.17	8.00	0.26
	2.80	0.03	5.00	0.13	8.50	0.16
	2.85	0.02	5.15	0.10	9.00	0.00
	3.00	0.00	5.25	0.08	100.00	0.00
	100.00	0.00	5.35	0.05		
			5.50	0.00		
			100.00	0.00		
SPAWNING	0.00	0.00	0.00	0.00	0.00	0.00
	0.10	0.00	0.10	0.03	4.10	0.00
	0.20	0.01	0.15	0.08	4.20	1.00
	0.32	0.02	0.20	0.15	5.60	1.00
	0.45	0.03	0.25	0.30	5.70	0.00
	0.60	0.06	0.30	0.51	100.00	0.00
	0.76	0.11	0.35	0.70		
	0.91	0.19	0.40	0.90		
	1.01	0.25	0.45	1.00		
	1.10	0.32	0.50	1.00		
	1.22	0.44	0.55	0.82		
	1.32	0.54	0.60	0.64		
	1.41	0.64	0.65	0.41		
	1.50	0.74	0.70	0.23		
	1.60	0.83	0.75	0.12		
	1.72	0.93	0.80	0.05		
	1.81	0.98	1.00	0.01		
	1.91	1.00	1.50	0.00		
	1.97	1.00	100.00	0.00		
	2.09	0.96				
	2.19	0.91				
	2.31	0.80				
	2.41	0.71				
	2.50	0.60				
	2.62	0.47				
	2.72	0.38				
	3.20	0.00				
	100.00	0.00				